Hydraulic Accumulator

The invention relates to a hydraulic accumulator with a piston which can be moved in the accumulator housing in its axial direction and which separates the gas side from the fluid side of the accumulator housing, on the periphery of the piston there being guide elements which are intended for interaction with the wall of the accumulator housing, and at least one sealing element, which, offset in the axial direction to the guide elements, is located in the peripheral section of the piston situated between the guide elements.

Piston accumulators of this type are commercially available and are widely used in hydraulic systems in a variety of applications, for example for storing energy, emergency actuation, leaking oil compensation, volume compensation, shock absorption, pulsation damping, and the like.

Long-term behavior is of very great importance for economical and reliable use of these accumulators. In order to guarantee operating behavior which is satisfactory in this regard, it must be ensured that the oil overflow from the fluid side which normally contains hydraulic oil to the gas side is minimized over the entire service life. Current hydraulic accumulators do not meet this requirement to an adequate degree.

The object of the invention is to devise a hydraulic accumulator of the type under consideration, which accumulator is characterized by improved long-term operating behavior compared to the prior art.

In a hydraulic accumulator of the type referred to in the foregoing, this object is achieved as claimed in the invention in that between the guide element which is nearest the piston side which borders the fluid side, and the sealing element which is offset in the axial direction to the gas side and which is the next one following in the axial direction, a pressure equalization channel discharges on the periphery of the piston which forms in the piston a fluid path to the fluid side and that in the pressure equalization channel there is a device which reduces its passage cross section.

The starting point of the invention is that it has been found that dirt particles contained in the hydraulic oil situated on the fluid side can adversely affect the long term behavior of the hydraulic accumulator, more precisely formulated, they can degrade the operating behavior of the sealing and guidance system between the periphery of the piston and the inside wall of the accumulator housing. In the hydraulic accumulators of the prior art, due to the motion of the piston there is a pressure difference between the fluid side and the intermediate space which is located on the periphery of the piston between the guide element on the fluid-side end of the piston and the sealing element which follows next in the axial direction. Due to this pressure difference, the volumetric flow into the intermediate space between the guide element and sealing element is small over the guide element. Entrained dirt particles may thus be deposited between the guide element and the piston and due to movements of the piston may lead to scratches which adversely affect the system.

The pressure equalization channel which is provided as claimed in the invention resolves the problem in that when the piston moves, there is no pressure difference at the guide element and thus a volumetric flow which may be loaded with dirt particles is not produced. In that moreover as claimed in the invention there is a device which reduces the passage cross section of the pressure

equalization channel, it is ensured that only a small fluid volume is involved in the process of pressure equalization.

The device which causes a reduction of the passage cross section of the pressure equalization channel preferably reduces the passage cross section so dramatically that as a result of the narrowing of the cross section the action of a particle filter arises. Even a minimum volumetric flow through the pressure equalization channel, as arises for pressure equalization during movements, thus does not lead to transport of dirt particles into the intermediate space which is located downstream of the guide element on the periphery of the piston.

The device which reduces the passage cross section can be a choke device, for example a nozzle which is inserted into the pressure equalization channel with a correspondingly small nozzle opening which acts as a particle filter.

Instead of a choking nozzle, as the device which narrows the cross section there can be a porous filter element which is inserted into the pressure equalization channel.

In preferred embodiments the guide element nearest the fluid side of the piston is located closely adjacent to the fluid-side end of the piston and is formed by a guide belt with a dirt stripper lip which extends at least approximately to the end of the piston. This also prevents dirt particles which may have already collected on the inside wall of the housing from being run over when the piston moves.

Preferably the guide belt which has the dirt stripper lip is made as a plain compression ring which sits in an annular groove of the piston periphery with a stripper lip which lengthens its radially outside annular surface on one side in the axial direction and which tapers towards its end edge.

The invention will be described in detail below using one exemplary embodiment which is shown in the drawings in which

- FIG. 1 shows a cutaway longitudinal section of a piston accumulator according to one exemplary embodiment of the invention, only the section of the accumulator housing being shown in which the piston is located, and
- FIG. 2 shows a partial longitudinal section of a piston guide element of the exemplary embodiment from FIG. 1, which section is drawn with a highly enlarged scale compared to FIG. 1, in the form of a plain compression ring with a projecting dirt stripper lip.

Of the exemplary embodiment of the hydraulic accumulator as claimed in the invention which will be described in the form of a piston accumulator, FIG. 1 shows only the section of the accumulator housing 1 in which the piston 3 is located. It forms a separating element which can move in the axial direction, i.e., along the longitudinal axis 4, between the gas side 5 and the fluid side 7 of the accumulator housing 1.

In hydraulic accumulators which are incorporated into hydraulic systems, the gas side 5 is conventionally filled with nitrogen gas, while the fluid side 7 in operation conventionally contains hydraulic oil. The sealing and guidance system which acts between the periphery of the piston 3 and the inside wall of the accumulator housing 1 and which prevents overflow of media from one piston side to the other piston side and which forms a piston guide when the piston 3 is moving, has a plurality of components which are provided on the periphery of the piston 3. In succession, in FIG. 1 in the axial direction from left to right, they are a guide element which is adjacent to the fluid-side end of the piston 3 in the form of a guide belt 9, a first piston seal 11 which is located at an axial

distance from it approximately in the central area of the piston 3, a second piston seal 15 which is further offset to the first piston seal in the axial direction against the fluid-side end 13 of the piston 3, and a guide element which is still further offset against the end 13 of the piston 3 in the form of a guide belt 17.

As is to be seen from FIG. 1 below, in the piston 3 there is a pressure equalization channel 19 which is formed from two blind holes which undergo transition into one another, one of which, proceeding from the end 13 of the piston 3, extends parallel to the longitudinal axis 4 and is designated 20, while the other hole which is designated as 21 extends at a right angle thereto, proceeding from the periphery of the piston 3. The hole 21 on the periphery of the piston discharges in the intermediate space which is located between the guide belt 17 and the piston seal 15 which follows in the axial direction. This space is designated as 23.

As a result of hydrodynamic circumstances, in operation when the piston 3 moves a pressure difference arises between the space 23 and the pressure of the hydraulic oil which is located on the fluid side 7. This pressure difference in the absence of a pressure equalization channel 19 leads to a slight volumetric flow over the guide belt 17, as already mentioned the entrained particles being deposited between the inside wall of the housing 1 and the piston 3 and possibly leading to disruptions of the sealing and guidance system. The pressure equalization channel 19 which is provided in the invention avoids the formation of a corresponding pressure difference and thus the corresponding oil overflow.

To preclude the danger of a fluid flow, which occurs in the pressure equalization channel 19 during the process of pressure equalization, also being able to cause particles to be brought into the space 23, the invention provides a narrowing of the passage cross section of the channel 19.

In the embodiment shown in the figure, this device is formed by a nozzle 25 which is inserted into the mouth of the hole 20 of the channel 19 on the end 13 of the piston 3. The nozzle hole 27 is chosen to be of such small dimension here that it acts as a particle filter so that no particles which have a dimension greater than that of the hole 27 can travel into the space 23 by way of the channel 19.

Instead of using a nozzle hole 27 of correspondingly small dimensions as a particle filter, a filter element could be inserted into the pressure equalization channel 19, preferably in its hole 20.

In order to avoid the further danger of adversely affecting the sealing and guidance system, which could occur due to dirt particles which have already collected on the inside wall of the housing 1, the guide belt 17 is made additionally as a stripper element with a structure which is shown particularly in FIG. 2. As shown, this stripper element, as the base part which performs the function of the piston guide in interaction with the inside wall of the housing 1, has a plain compression ring 29 which is supported in an annular groove 31 which is machined into the periphery of the piston 3. The outer annular surface 33 of the plain compression ring 29 which forms the guide surface is lengthened in the axial direction to form the stripper lip 35. The latter extends over an axial length which is somewhat greater than half the axial length of the plain compression ring 29, see FIG. 2. As is likewise to be clearly seen from FIG. 2, the lip 35 tapers, proceeding from its root on the plain compression ring 29, as far as the end edge 37 with a tapering angle α, which in the example shown is approximately10 degrees relative to the axial direction. As is likewise to be seen from FIG. 2, the radial thickness of the lip 35 on its root which borders the plain compression ring 29 is somewhat less than half the radial thickness of the plain compression ring 29.

In the guidance and stripper element which forms the guide belt 17, the plain compression ring 29 and the stripper lip 35 which is formed integrally with it consist of an elastomer material so

that the plain compression ring 29 can be snapped into the annular groove 31 on the piston 3 and the lip 35 extends projecting in a flexible manner. As is to be seen in FIG. 1, the lip 35 extends over the end-side peripheral section 39 of the piston 3 which section extends into the area of the fluid-side end 13, which peripheral section is somewhat reduced in outside diameter. Due to the intermediate space formed in the section 39 between the piston 3 and the lip 35, it can be conformed in an elastically flexible manner to the inside wall of the housing 1, by means of which the lip 35 achieves an optimum stripper action.

Efficient operating behavior can be ensured over a very long service life by the configuration of the guidance and sealing system provided as claimed in the invention, with pressure equalization between the space 23 on the piston periphery and the fluid side 7 and the measures which are provided in combination herewith to prevent settling of dirt particles on the inside wall of the housing 1.

The guide belt 9 which is shown on the left when viewed in the direction of looking at FIG. 1 can be designed comparably to the guide belt 17 which is shown on the right and/or can be replaced by it.